



Migrating to 64-bit Industry-Standard Architectures

Executive Overview

Intel® Xeon™ processors with the new 64-bit extensions technology deliver standards-based 64-bit computing and large memory addressability while maintaining complete 32-bit compatibility and performance – all in one platform. The innovations in the new Xeon processor-based platforms and additional supporting technology advancements allow customers who purchase servers with these processors to install and run all of their existing 32-bit applications with excellent performance and to adopt 64-bit applications when their applications have been certified to run on a 64-bit operating system – all on the same platform or even the same physical server.

As businesses and public organizations review their IT strategies for the next few years, Dell believes they are faced with a new decision. It's not whether or not they migrate to 64-bit servers built on an industry-standard platform, but, more importantly, where and when they make this migration. With multiple 64-bit environments to choose from, the migration strategy takes on an even greater importance.

Previously, for the countless infrastructure, web and general business applications, the issue of moving to 64-bit environments was not deemed critical due to unclear performance gains and the sheer scope of the cost and work to migrate. In the near future, with the new Intel Xeon processors with 64-bit extensions becoming available, 64-bit computing should move to a new level of flexibility and price/performance value.

Until now, the cost and complexity of 32-bit and 64-bit systems has generally dictated that infrastructure applications stayed on 32-bit platforms and business logic applications ran on 64-bit platforms. Compared to proprietary RISC systems, an Itanium®-based solution can have a compelling price/performance advantage for compute-intensive applications such as database transaction processing. Customers have done the analysis and are moving their business logic applications to Itanium-based platforms and reaping the benefits of high performance and low cost.

However, it is not just hardware that changes as you migrate from 32-bit to 64-bit, it's also the software. Operating systems, drivers and applications - the complete platform software stack needs to change in order to take advantage of 64-bit computing. This is why a methodical, practiced approach to migration can pay off for you.

To successfully map out a strategy, you need to consider the following:

- What applications are candidates for 64-bit migration? (Database, heavy workload, and business applications are the most likely candidates.)
- Choosing the right target architecture for your applications (Itanium 2 or Xeon architectures).
- What is the availability of the operating system, applications and drivers for the platform you need? (Windows®/Linux®; Microsoft SQL Server/Oracle®/SAP®; RAID/FC/LAN)



- What are the services required to assist you in a successful transition?

This paper is intended to help you lay the groundwork for beginning your evaluation process.

Choosing the Right Architecture for Your Application

In choosing the right architecture for your applications, you must first determine the performance parameters of the application and how the data will be handled. The data width of the processor execution and the memory size can be key performance factors for the overall system, but depending on the application/environment, their impact can be anywhere from moderate to massive. Having the fastest 8-cylinder engine in your car can be a real asset when you've got a long stretch of open highway, but it does you no good in bumper-to-bumper city traffic.

Factors that will have an impact in choosing your architecture include the following:

Sequential vs. Random Requests – Video decoding/streaming, for instance, requires a continuous set of sequential/structure calculations and takes greater advantage of the performance of 64-bit platforms. File and print sharing, in contrast, requires the processor to address multiple low-level requests from multiple users in a much more random fashion, making it less dependant on the processor.

Logic-Based Requests vs. Load-Based Requests – Life sciences applications, for instance, tax the processor heavily by requesting large, complex calculations and floating point calculations. Domain Name Services (DNS) or Secure Socket Layer (SSL) applications will require less complex algorithms but ask them over and over again.

Memory Set – The amount of memory that is not only available, but more importantly, utilized by the application, can have a tremendous impact on the overall performance. In the case of large memory requirements, 64-bit platforms are a better choice because of their large addressable memory space.

In analyzing these different variables, we start to see that applications generally fall into three categories:

Compute-Intensive Applications – These include vertical applications and business-critical applications, such as life sciences/High Performance Computing Cluster (HPCC) applications, database backend (SQL Server, Oracle, and DB2®), business applications such as Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP) applications and eBusiness applications (such as online commerce stores). These applications will benefit from 64-bit processors.



Compute/Load Balanced Applications – These include infrastructure-based applications such as internet caching, security, DNS, DHCP, SSL and database front ends. These applications may or may not benefit from 64-bit processors, so some evaluation in your environment must be done before deciding to migrate.

Standard Infrastructure Applications – These include simple file and print sharing, resource sharing and less-critical, single use/low volume business applications. In general, these are less processor-intensive and will not benefit as much from a 64-bit processor.

Once you have categorized your applications based on this usage model, you can begin to determine which architectural platform will best suit your needs.

X86/32-bit

A large portion of the existing x86/32-bit software will remain on 32-bit platforms for some time and will continue to be compatible with Intel's new 64-bit extensions technology that will be found on its new Xeon processors. Many of the thousands of commercial and internally developed server applications will not necessarily benefit from the wider execution paths or greater memory capacity benefits of 64-bit computing. These applications were written on and for 32-bit architectures and have inherent limits therein, like 2GB memory space. Even as server consolidation occurs, these applications derive little benefit from 64-bit computing. While they may eventually move to 64-bit extended system architectures, they will most likely remain in 32-bit mode.

64-bit Itanium

The Intel Itanium 2 architecture delivers the top raw TPC-C performance at a compelling cost relative to RISC platforms with a robust, mature 64-bit ecosystem for standards-based systems today¹. This makes Itanium 2-based servers an attractive alternative to expensive, proprietary 64-bit solutions.

The Dell™ PowerEdge™ 3250 dual processor server is an excellent choice for processor and memory-intensive applications, as the high-performance Itanium 2 processor executes 64-bit instructions and can access up to 16GB of memory.

Applications such as HPCC, technical computing, life sciences, oil and gas research and graphical rendering are taking advantage of Itanium 2 today, mostly in dual processor configurations. Business applications, database, and other compute-intensive applications are now available to run on Itanium 2 versions of both Linux and Microsoft Windows Server 2003 operating systems. These applications have been developed and tuned specifically to run on Intel Itanium 2 processors and take advantage of the large 64-bit instructions and memory sets. With access to large amounts of memory, these

¹ Results for both performance and price/performance are based on TPC-C benchmarks as of 2/17/04. Current results can be found at <http://www.tpc.org>.



applications use a flat memory address space, and rely less on resource hogging memory managers and paging to hard drives.

Large processor caches, from 1.5MB to 6MB, deliver great performance for these compute-intensive applications by providing ready access to cached data.

Application vendors who have traditionally supported more expensive proprietary platforms for their business applications that run on RISC platforms (such as RS/6000®, AS/400®, PA-RISC, Sun®, etc.) can now migrate to an industry-standard Itanium 2 platform because of the performance, reliability and standards-based architecture. Business applications like SAS®, IBM® DB2, Oracle 9 and SAP® that previously delivered their greatest performance on proprietary platforms are now available on industry-standard platforms like Dell PowerEdge servers.

64-bit Extensions Technology

With the introduction of the Intel 64-bit extensions technology into the Intel Xeon family, a new class of 64-bit computing is now available. The new technology builds on the existing 32-bit Intel architecture that is running millions of servers worldwide. The 64-bit extensions technology is expected to deliver a flexible, lower cost platform than Itanium 2 that supports both 32-bit and 64-bit for those applications that will benefit from features like 64-bit operations and large memory addressability. In addition, other performance enhancing features are expected to be included in the new Xeon processor architecture, including faster core processor speeds, frontside bus speeds, PCI Express™ I/O and graphics, and support for double data rate (DDR2) memory.

The Xeon architecture with 64-bit extensions technology will be able to execute instructions at both 32-bit and 64-bit levels and is an excellent platform for mixed purpose or infrastructure servers that could be running a variety of applications on a single platform. 64-bit extension technology will deliver cost-effective performance and scalability, allowing those applications that benefit from large memory addressability to migrate seamlessly on a single, standard platform.

Applications such as directory services, DNS services, database front-end and, eventually, messaging/groupware will benefit from 64-bit extension technology and the new supporting technologies. These new enhancements are expected to provide not only greater performance than the existing 32-bit Xeon architecture, but, more importantly, a better price/performance relative to Itanium 2 for the large number of servers required to deliver these services in the average enterprise.

A key consideration of the 64-bit extension technology is the availability of operating systems and applications. While legacy 32-bit operating systems, drivers and applications are supported seamlessly on 64-bit extended platforms, in order to run in true 64-bit mode the entire software stack must be recompiled for 64-bit extensions. Today, most Linux® variants are available for 64-bit extended systems. Microsoft has announced that it plans to release a version of Windows Server 2003 for 64-bit extended systems to complement its 32-bit and Itanium versions. It is important to note that



Itanium software does not run on 64-bit extended systems and vice-versa. Applications, as well, will need to be written to support 64-bit extended systems.

The value of the 64-bit extended system architecture is the ability to move from a 32-bit environment to a 64-bit environment as software support becomes available, so it is critical to understand the availability landscape for the applications you need. The good news is that regardless of when the software becomes available, your hardware investment today is secure. With the new Xeon 64-bit extension processors, you can wait for 64-bit migration because you can run your existing software in 32-bit mode initially and then migrate to 64-bit mode as needed. Depending on your application needs, the 64-bit extended system architecture can be the perfect choice for migrating on your terms and on your timeline.

The Building Blocks of the 64-bit Platform

It's not a matter of just installing a new processor into a system to move from 32-bit to 64-bit computing. A 64-bit computing platform goes much further beyond the bus width of the processor; the processor and memory bus are just two of the many components that make up the complete platform.

There are 5 levels of complexity in designing a 64-bit platform:

- Hardware, including processor, chipset and peripherals
- Firmware and BIOS
- Device Drivers
- Operating System
- Application

Each of these areas needs to be addressed in order to complete a 64-bit platform.

To begin with, hardware starts with the processor. In order to enable 64-bit addressability in its new Xeon processors, Intel added 16 additional registers, 8 for SSE and 8 general purpose registers. Double precision integer support was also added, as well as extended memory addressability through 64-bit pointers/registers. These architectural changes allow the new Xeon processors to not only execute 64-bit instructions, but also allow for 64-bit memory addressability.

Device drivers that were written for 32-bit operating systems will not work on 64-bit operating systems, including Itanium and Xeon in 64-bit mode. Driver availability could become a bottleneck in your migration because any 64-bit operating system will require its own set of drivers and many of those will not be delivered by the operating system vendor, but rather by the device manufacturer. This is true of both Windows and Linux systems. A critical step in the process, after determining the hardware platform, is ensuring that drivers exist for all peripherals based on the operating system of choice.



Operating system support is already established for Itanium 2 platforms and will be available in the future for 64-bit extended system platforms. For Windows Server 2003, currently there are two versions: one that supports x86 32-bit systems and one that supports the 64-bit Itanium 2 family of processors. Microsoft also is developing a third version of Windows Server 2003 that supports what it calls 64-bit Extended Systems and plans to release this in the second half of 2004. Remember, 32-bit software that runs on current Xeon processors will run on 64-bit extended system platforms in 32-bit mode but Windows Server 2003 for 64-bit Extended Systems is not expected to be able to run on existing and previous Xeon processor platforms. More information can be found at: <http://www.microsoft.com/windowsserver2003/64bit/extended/default.mspx>

Most major Linux vendors, including Red Hat® and SUSE®, provide Itanium 2 support today, as well as support for 64-bit extended systems in their 64-bit operating systems. The Linux operating system simply detects the architecture of the platform it resides on and loads the appropriate binaries. This means that Linux customers should be able to deploy the same operating system on Itanium and 64-bit extended systems. However, there will still be separate 32-bit and 64-bit versions of Linux from these vendors.

Applications must be compiled by their developers using 64-bit tools and libraries in order to take advantage of the high performance 64-bit instructions and 64-bit memory addressing. An important consideration on applications is not only inspecting the code that comes directly from your vendor, but also investigating any custom code that has been developed, either in-house or outsourced, that ties to these applications.

A thorough application inventory of all of the pieces and code that go into running your business is critical. It would do no good to launch a 64-bit platform with a 64-bit operating system and application only to find out that a custom module that is required to run the application will not run because it has not been compiled for a 64-bit environment.

Once the platform, drivers and operating system are in place, the application is the final step. While 64-bit extended system platforms can run 32-bit and 64-bit application software simultaneously, this can only be done if the 64-bit extended operating system and drivers are installed. If a 64-bit extended operating system and drivers are installed, 32-bit applications on a 64-bit extended system and operating system are predicted to see improved performance. This may vary based on application memory utilization, but even in low demand applications, memory access and handling should be more efficient on 64-bit extended system platforms. For 32-bit applications with high memory utilization, constant paging and virtual address mapping, performance can be expected to increase on 64-bit extended systems because of access to more memory. Deploying 64-bit applications on a 32-bit platform and operating system is not supported.

Migrating from UNIX

Organizations today are constantly being asked to improve performance, availability, manageability and serviceability - and at the same time reduce costs and complexity. Migrating from proprietary UNIX® platforms to Dell's Intel architecture-based servers



running either Linux or Microsoft Windows operating systems helps open up a world of freedom. Freedom to choose, freedom to save money, flexibility in service spending – freedom to save you and your organization time and money.

The Potential ROI Advantages from UNIX Migration:

Increased Flexibility and Serviceability

Building solutions and services based on industry standard Intel platforms can help increase your flexibility and your organization's ability to react to customer needs and to changing business conditions, allowing improved efficiencies for you. And that can result in increased revenue, better utilized resources, and happy customers.

Optimized Availability

Industry standard server platforms from Dell deliver high data availability for access to business-critical applications and data with flexible choice of service and support options to help maximize system uptime. These same industry standard Intel-based Dell PowerEdge servers also help you simplify and standardize on operational procedures through our overall system design and time-saving Intelligent IT product offerings.

Outstanding Performance

Dell is focused on delivering maximum performance with standards based solutions while ensuring the right mix of cost effective solutions with value at every level.

Simplified Manageability

Dell OpenManage™ systems management helps accelerate deployments, simplify operations, ensure data availability and maximize the efficiency of corporate IT staffs.

Balanced Value and Cost

Dell's highly efficient direct model positions us to provide a low cost of ownership. Additionally we offer value-oriented metrics such as return on investment (ROI), like our Unix Migration ROI Analysis Tool, which captures both the estimated costs and benefits of your IT investments. We have also tailored our enterprise product and services to help ensure you get great business value through your relationship with Dell.

While investigating the migration from 32-bit to 64-bit, it is also the perfect time to take stock in existing UNIX applications and determine whether it makes sense to migrate these applications at the same time.

To learn more about UNIX migration, visit:

http://www1.us.dell.com/content/topics/global.aspx/solutions/en/unix_migrate?c=us&cs=555&l=en&s=biz



Building a Migration Plan

It is time to put your knowledge to practical use by outlining a migration plan from 32-bit to 64-bit computing.

Initially, you should map out the applications that are currently running and put them into three categories:

- Those that will likely see great performance increases from a 64-bit environment.
- Those that are expected to see an increase in performance that is only moderate compared to the first group or will run on systems that will host a mixture of 32-bit and 64-bit applications.
- Those that are predicted to see little or no increase in performance from a 64-bit environment.

The following checklist, in order, should help you through the decision process and present you with a strong migration plan.

Migration Workflow

- Determine the potential business impact of moving from 32-bit to 64-bit
 - Is there a cost savings?
 - Is there an increase in productivity/capacity?
 - Can consolidation of servers/storage occur?
- Identify applications that would need to migrate
 - Is the application available in a 64-bit version?
 - Are there any custom modules or code that has been developed in-house or outsourced that will need to run with this application?
 - What other applications are running on that server? Are they available in 64-bit versions?
 - What supporting applications or services are required to run the application?
- Identify the operating system that will run the application
 - Is a 64-bit version of the OS available?
 - Is this version compatible with other versions of the operating system (i.e., will you increase support/management costs by adding this platform to your environment?)
 - Are management tools available?
- Identify the hardware platform
 - Is the application better suited for a pure 64-bit environment (Itanium 2) or better suited for a more cost-effective 64-bit environment (64-bit extended system)?
 - Are drivers available for all of the peripherals that will be required?



Conclusion

There are now two 64-bit Intel alternatives for extending your IT infrastructure – Itanium 2 and Xeon with 64-bit extensions technology. Depending on your particular needs – highest raw performance or best price/performance – there is a 64-bit solution for your organization.

In addition, 32-bit applications will continue to have a place in your IT environment, regardless of whether they run on 32-bit or 64-bit extended systems. Because of the flexibility in 64-bit extended systems, these 32-bit applications can run in a mixed environment alongside 64-bit applications on the same server.

Because these different platforms require different operating systems, drivers and applications, it is important to take this into consideration when planning your migration. From the hardware platforms through the drivers, operating systems and applications, everything must be designed to work in a new 64-bit environment in order to maximize your success.

THIS WHITE PAPER IS FOR INFORMATIONAL PURPOSES ONLY, AND MAY CONTAIN TYPOGRAPHICAL ERRORS AND TECHNICAL INACCURACIES. THE CONTENT IS PROVIDED AS IS, WITHOUT EXPRESS OR IMPLIED WARRANTIES OF ANY KIND.

Dell, PowerEdge, and OpenManage are trademarks of Dell Inc. Intel and Itanium are registered trademarks and Xeon is a trademark of Intel Corporation. Other trademarks and trade names may be used in this document to refer to either the entities claiming the marks of their products. Dell disclaims proprietary interest in these marks and names of others.

© Copyright 2004 Dell Inc. All rights reserved. Reproduction or translation of any part of this work beyond what is permitted by U.S. copyright laws without the written permission of Dell Inc. is unlawful and strictly forbidden.